



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/063,576	05/03/2002	Ho-Ming Tong	8317-US-PA	4447

31561 7590 09/11/2003

JIANQ CHYUN INTELLECTUAL PROPERTY OFFICE
7 FLOOR-1, NO. 100
ROOSEVELT ROAD, SECTION 2
TAIPEI, 100
TAIWAN

EXAMINER

PHAM, THANHHA S

ART UNIT PAPER NUMBER

2813

DATE MAILED: 09/11/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/063,576

Applicant(s)

TONG ET AL.

Examiner

Thanhha Pham

Art Unit

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 July 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-38 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-38 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s) _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

1. Claims 11, 19-21, 32 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

- With respect to claim 11, "the step of bonding the UBM onto the active surface of the wafer" lacking antecedent basis should be changed to "the step of forming the UBM on the active surface of the wafer"
- With respect to claim 19, it is not clear where "the wettable layer" comes from and is located – see claim 10 that does not cite limitation of the wettable layer.
- With respect to claim 20, it is not clear where "the wettable layer" comes from and is located – see claim 10 that does not cite limitation of the wettable layer.
- With respect to claim 32, it is not clear where "the wettable layer" comes from and is located – see claim 22 that does not cite limitation of the wettable layer.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

Art Unit: 2813

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-4, 10-14, 17, 22-27, and 30 are rejected under 35 U.S.C. 102(b) as being anticipated by Akram [US 5,903,058].

➤ With respect to claim 1, Akram (figs 1's and col 1-3) discloses the claimed method forming a bump on a wafer, wherein the wafer has an active surface (12, figs 1d, col 2 lines 1-22), and the active surface is provided with a passivation layer (16) and a bonding pad (14) exposed by the passivation layer, the method comprising:

forming an adhesive layer (28, fig 1e, col 2 lines 23-39) on the active surface of the wafer to cover the bonding pad (14) and the passivation layer (16);

forming a barrier layer (30, fig 1e, col 2 lines 23-39) on the adhesive layer;

forming a wettable layer (32, fig 1e, col 2 lines 23-39) on the barrier layer;

forming a photomask (36, fig 1f, col 2 lines 40-44) on the wettable layer (32) by a photolithography process, wherein the photomask exposes a portion of the wettable layer;

removing the exposed wettable and sequentially the barrier layer and the adhesive layer thereunder by etching, until the active surface of the wafer is exposed (fig 1g, col 2 lines 44-47);

removing the photomask (fig 1g, col 2 lines 44-47);

bonding a conductive stud (42, fig 1h, col 2 lines 47-51 & 58-67 and col 3 lines 1-3) onto the wettable layer, wherein the conductive stud is made of a material selected from tin/lead alloy, leadless alloy and pure tin; and

Art Unit: 2813

performing a reflow process to form a ball-shaped bump (42, fig 1h, col 1 lines 57-64).

➤ With respect to claims 10-11, as being best understood, Akram (figs 1's and col 1-3) discloses the claimed method of forming a bump on an active surface of a wafer, the method comprising:

forming an under ball metallurgy UBM (28/30/32, fig 1e, col 2 lines 23-39) on the active surface of the wafer wherein the step of forming the UBM onto the active surface of the wafer comprises: forming an adhesive layer (28) on the active surface of the wafer; forming a barrier layer (30) on the adhesive layer; and forming a wettable layer (32) on the barrier layer;

forming a photomask (36, fig 1f, col 2 lines 40-44) on the UBM by photolithography to partially expose the UBM (28/30/32);

removing the exposed portion of the UBM by etching, until the active surface of the wafer is exposed (fig 1g, col 2 lines 44-47);

removing the photomask (fig 1g);

bonding a conductive stud (42, fig 1h, col 2 lines 47-51 & 58-67 and col 3 lines 1-6) onto the UBM; and

performing a reflow process to form a ball-shaped bump (42, fig 1h, col 1 lines 57-64).

➤ With respect to claims 22 and 24, Akram (figs 1's and col 1-3) discloses the claimed method of forming a bump on an active surface of a wafer, the method comprising:

Art Unit: 2813

forming a UBM (28/30/32, fig 1e, col 2 lines 23-39) on the active surface of the wafer wherein the step of forming the UBM onto the active surface of the wafer comprises: forming an adhesive layer (28) on the active surface of the wafer; forming a barrier layer (30) on the adhesive layer; and forming a wettable layer (32) on the barrier layer;

partially removing the UBM, until the active surface of the wafer is exposed (fig 1g, col 2 lines 44-47); and

bonding a conductive stud (42, fig 1h, col 2 lines 47-51 & 58-67 and col 3 lines 1-6) onto the UBM.

- With respect to claims 2, 12 and 25, Akram (col 2 lines 23-39) discloses the adhesive layer (28) is formed of titanium, titanium tungsten alloy, aluminum and chromium.
- With respect to claims 3, 13 and 26, Akram (col 2 lines 23-39) discloses the barrier layer (30) is formed of a material selected from a group consisting of nickel vanadium alloy, chromium copper alloy, and nickel.
- With respect to claims 4, 14 and 27, Akram (col 2 lines 23-39) discloses the wettable (32) layer is formed of a material selected from a group consisting of copper, palladium, and gold.
- With respect to claims 17 and 28, Akram (col 2 lines 58-67 and col 3 lines 1-3) discloses the conductive stud (42) is formed of tin lead alloy.

3. Claims 33-36 are rejected under 35 U.S.C. 102(b) as being anticipated by Chakraworty [US 6,181,569].

Chakraworty (figs 5's-8's and col 1-15, discloses the claimed method of forming a bump on a UBM that has been formed on an active surface of a wafer, the method comprising:

bonding a conductive stud (311-1, fig 5a, col 8 lines 57-67 and col 9 lines 1-54) on the UBM (310) by wire bonding (wire bonder) *[claim 33]*;

reflowing to form a ball-shaped bump ,after the conductive stud is bonded onto the UBM (col 9 lines 54) *[claim 34]*; and

flattening the conductive stud after the conductive stud is bonded onto the UBM (fig 8c, col 11 lines 1-6) *[claim 35]* wherein flattening the conductive stud is achieved by polishing *[claim 36]*.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 5, 7, 18, 19, 23, 31 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Akram [US 5,903,058] as applied to claims 1, 10 and 22 above, in further view of Kimijima et al [JP 08-213399].

➤ With respect to claims 5, 18 and 31, Akram substantially discloses the claimed method including using the conductive stud formed of tin lead alloy. Akram is silent about the percentage of lead of more than 90%. However, the claimed range of lead

Art Unit: 2813

percentage of the conductive stud is considered to involve routine optimization while has been held to be within the level of ordinary skill in the art. As noted in *In re Aller* 105 USPQ233, 255 (CCPA 1955), the selection of reaction parameters such as temperature and concentration would have been obvious.

"Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art...such ranges are termed "critical ranges and the applicant has the burden of proving such criticality... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation."

See also In re Waite 77 USPQ 586 (CCPA 1948); *In re Scherl* 70 USPQ 204 (CCPA 1946); *In re Irmischer* 66 USPQ 314 (CCPA 1945); *In re Norman* 66 USPQ 308 (CCPA 1945); *In re Swenson* 56 USPQ 372 (CCPA 1942); *In re Sola* 25 USPQ 433 (CCPA 1935); *In re Dreyfus* 24 USPQ 52 (CCPA 1934).

➤ With respect to claims 7, 19 and 32, Akram substantially discloses the claimed method including forming the conductive stud having a top surface and a bottom surface opposite to the top surface wherein the bottom surface being contact with the wettable layer. Akram fails to teach the top surface of the conductive stud is flattened by polishing before reflow.

However, Kimijima et al teaches flattening the conductive stud (20, figs 2a-c, abstract) by polishing before reflow to provide a better control of size of the conductive stud (21, providing homogeneous bumps having uniform sizes).

Therefore, it would have been obvious for those skilled in the art to modify process of Akram by polishing the conductive stud before reflow, as taught by Kimijima et al, to provide a better size-controlled bump in the semiconductor device.

➤ With respect to claim 23, Akram substantially discloses the claimed method including reflowing the conductive stud to form the shape of ball for the solder ball (42). Akram is silent about the sequence of the reflowing process being after bonding the conductive stud onto the UBM. However, selection of any order of performing process steps is *prima facie* obvious in the absence of new or unexpected results *In re Burhans*, 154 F.2d 690, 69 USPQ 330 (CCPA 1946). Moreover, reflowing the conductive stud to form the shape of ball for bump interconnection after bonding the conductive stud onto the UBM is a known technique of forming bump of solder ball in a semiconductor device. See Kimijima et al as an evidence that shows reflowing the conductive stud to shape the bump of ball (21) after bonding the conductive stud (20) on the UBM (13). It would have been obvious for those skilled in the art to the known technique of performing reflowing process after bonding the conductive stud onto the bump, as being claimed, in the process of Akram to form bump of ball-shaped for interconnection of the semiconductor device.

5. Claims 6, 8-9, 15-16, 20-21 and 28-29, as being best understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Akram [US 5,903,058]

Art Unit: 2813

as applied to claims 1, 10 and 22 above, further in view of Chakravorty [US 6,181,569] and Hasaka [US 6,475,897].

➤ With respect to claims 6, 15-16 and 28-29, Akram et al substantially discloses the claimed method but does not expressly teach using the conductive stud formed of leadless alloy, tin copper alloy, tin silver alloy, tin magnesium alloy, tin zinc alloy, indium silver alloy, tin bismuth alloy, tin indium alloy, bismuth indium or tin. However, such claimed materials are known materials of conductive stud in forming bumps in semiconductor device. Selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co., Inc. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945) "Reading a list and selecting a known compound to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig - saw puzzle." 65 USPQ at 301.). See Hosaka as an evidence that shows a usage of claimed material for forming the conductive stud.

➤ With respect to claims 8-9 and 20-21, Akram substantially discloses the claimed method including bonding the conductive stud on the UBM/wettable layer of the UBM. Akram does not expressly teach bonding the conductive stud (42) onto the wettable layer of UBM by: providing a wire; melting one tip end of the wire to form a ball; pressing the ball onto the wettable layer wherein the ball being press onto the wettable layer while applying ultrasonic wave; and separating the ball from the wire to form the conductive stud on the wettable layer. Instead, Akram teaches bonding the conductive stud onto the wettable layer of UBM by stenciling, electroplating or evaporation.

However, Chakravorty (fig 5a, col 9 lines 11-30) teaches using wire bonding is an equivalent technique to stenciling, electroplating or evaporation for bonding the conductive stud (311-1) onto the UBM/wettable layer of the UBM. Hoskaka teaches using the wire bonding technique by providing a wire, melting one tip of the wire to form a ball, pressing the ball onto a surface where the ball being needed to be bonded to while applying ultrasonic wave, and separating the ball from the wire to form the conductive stud.

Therefore, it would have been obvious for those skilled in the art to modify process of Akram by providing the wire, melting the tip of the wire to form the ball, pressing the ball onto the wettable layer while applying ultrasonic wave and separate the ball from the wire, as being claimed, per taught by Chakravorty and Hosaka, to bond the conductive stud onto the UBM/the wettable layer of the UBM in a semiconductor device – Since Chakravorty teaches using wire bonding is the equivalent technique to the bonding technique of Akram, and Hoskata teaches the wire bonding including providing the wire, melting the tip of the wire to form the ball, pressing and separating the ball to form the conductive stud.

6. Claims 37 and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chakravorty [US 6,181,569] as applied to claim 33 above, and further in view of Hosaka [US 6,475,897].

Chakravorty substantially discloses the claimed method except expressly mentioning in written disclosure that the conductive stud is bonded on the UBM by the wire bonding comprising: providing a wire, melting one tip end of the wire to form a

Art Unit: 2813

ball;, pressing the ball onto the UBM wherein the ball being press onto the UBM layer while applying ultrasonic wave, and separating the ball from the wire to form the conductive stud on the UBM.

Hosaka teaches using the wire bonding technique by providing a wire, melting one tip of the wire to form a ball, pressing the ball onto a surface where the ball being needed to be bonded to while applying ultrasonic wave, and separating the ball from the wire to form the conductive stud.

Therefore, it would have been obvious for those skilled in the art to bond the conductive stud on the UBM by the wire bonding comprising: providing a wire, melting one tip end of the wire to form a ball;, pressing the ball onto the UBM wherein the ball being press onto the UBM layer while applying ultrasonic wave, and separating the ball from the wire to form the conductive stud on the UBM in the process of Chakravorty -- since such claimed steps for wiring bonding the conductive stud are known and basic steps to bond the conductive stud (see Hosaka as an evidence).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanhha Pham whose telephone number is (703) 308-6172. The examiner can normally be reached on Monday-Thursday 8:00 AM - 7:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr., can be reached on (703) 308-4940. The fax phone

Art Unit: 2813

number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Thanhha Pham


CARL WHITEHEAD, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800